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THE RUMFORD FUND.

Awards of the Premium and Grants for Research in Light and Heat.

Compiled by Charles R. Cross.

Received April 29, 1921. Presented May 11, 1921.

A number of years since the Rumford Committee came to realize that there was a great lack of knowledge in the educated community in general and to some extent even within the Academy itself regarding the Rumford Fund and the part it had played in stimulating scientific research in this country. For this reason it was decided to issue a somewhat detailed printed statement which should give an account of the origin of the Rumford Fund and the circumstances under which it came to assume its present important position. Of still greater moment was the fact that no collected statement had ever been published of the grants for research which had been made during the previous years, of the papers which had been published with aid from the Fund, or even of the Rumford Medals which had been awarded by the Academy. To remove this deficiency the Rumford Committee prepared a comprehensive paper which was printed by the Academy in 1905, making a pamphlet of thirty-two pages, entitled "The Rumford Fund." Together with a historical sketch were given a list of the awards of the Rumford Premium by the American Academy of Arts and Sciences, 1839 to 1904, a list of the awards of the Rumford Premium of the Royal Society of London, 1802 to 1904, a list of the grants for research made from the Rumford Fund, 1832 to May 1905, and a list of papers published with aid from the Rumford Fund in the Memoirs or Proceedings of the Academy, 1833 to 1905.

A Supplement of nineteen pages to this publication was issued in 1912, which continued the list of awards of the Rumford Premium of the Academy up to and including 1912, and gave data regarding the individual medals of the complete series which had not been ascertained previously. It also continued the lists of the Royal Society's awards of that Premium, from 1905 to 1910, and the Grants for Research made by the Rumford Committee from October, 1905 to May, 1912 together with a list continued up to that date of the papers published by the Academy from 1905 to 1912 with aid from the Rumford

Fund. In addition to these there was given a list as reported by their authors of all published researches which had received aid from the Rumford Fund but which had been published elsewhere than in the publications of the Academy from 1892 to 1912. Prior to 1892 it had been understood that researches thus aided should be presented for publication to the Academy.

At the time of issue of the 'Supplement' it was felt by the Committee that it would be well regularly, perhaps every five years, to continue the lists of grants and published papers up to date. 1917, however, was not a favorable time for doing this, and it was evident that in any event such regular publication would most conveniently begin at the end of the second decade of the century. It seemed best also to print future publications of the kind in the Proceedings of the Academy.

The list of grants now published includes all from the beginning down to and including December, 1920. They have also been numbered, every entry being included for convenience of reference, although it may not indicate actual appropriation of funds. A complete list of the awards of the Rumford Premium is also given.

It is intended shortly to publish a continuation of the lists of published papers up to and including December, 1920.

Awards of the Rumford Premium of the American Academy.

1839. Robert Hare, of Philadelphia, for his invention of the compound or oxyhydrogen blowpipe.

1862. John Ericsson, of New York, for his improvements in the management of heat, particularly as shown in his caloric engine of 1858.

1865. Daniel Treadwell, of Cambridge, for improvements in the management of heat, embodied in his investigations and inventions relating to the construction of cannon of large calibre, and of great strength and endurance.

1866. Alvan Clark, of Cambridge, for his improvements in the manufacture of refracting telescopes, as exhibited in his method of local correction.

1869. George Henry Corliss, of Providence, for his improvement in the steam-engine.

1871. Joseph Harrison, Jr., of Philadelphia, for his mode of constructing steam-boilers, by which great safety has been secured.

1873. Lewis Morris Rutherfurd, of New York, for his improvements in the processes and methods of astronomical photography.

1875. John William Draper, of New York, for his researches on radiant energy.

1880. Josiah Willard Gibbs, of New Haven, for his researches in thermodynamics.

1883. Henry Augustus Rowland, of Baltimore, for his researches in light and heat.

1886. Samuel Pierpont Langley, of Allegheny, for his researches in radiant energy.

1888. Albert Abraham Michelson, of Cleveland, for his determination of the velocity of light, for his researches upon the motion of the luminiferous ether, and for his work on the absolute determination of the wave-lengths of light.

1891. Edward Charles Pickering, of Cambridge, for his work on the photometry of the stars and upon stellar spectra.

1895. Thomas Alva Edison, of Orange, N. J., for his investigations in electric lighting.

1898. James Edward Keeler, of Allegheny, for his application of the spectroscope to astronomical problems, and especially for his investigations of the proper motions of the nebulae, and the physical constitution of the rings of the planet Saturn, by the use of that instrument.

1899. Charles Francis Brush, of Cleveland, for the practical development of electric arc-lighting.

1900. Carl Barus, of Providence, for his various researches in heat.

1901. Elihu Thomson, of Lynn, for his inventions in electric welding and lighting.

1902. George Ellery Hale, of Chicago, for his investigations in solar and stellar physics and in particular for the invention and perfection of the spectro-heliograph.

1904. Ernest Fox Nichols, of New York, for his researches on radiation, particularly on the pressure due to radiation, the heat of the stars, and the infra-red spectrum.

1907. Edward Goodrich Acheson, of Niagara Falls, for the application of heat in the electric furnace to the industrial production of carborundum, graphite, and other new and useful substances.

1909. Robert Williams Wood, of Baltimore, for his discoveries in light, and particularly for his researches on the optical properties of sodium and other metallic vapors.

1910. Charles Gordon Curtis, of New York, for his improvements in the utilization of heat as work in the steam turbine.

1911. James Mason Crafts, of Boston, for his researches in high-temperature thermometry and the exact determination of new fixed points on the thermometric scale.

1912. Frederic Eugene Ives, of Woodcliff-on-Hudson, for his optical inventions, particularly in color photography and photo-engraving.

1913. Joel Stebbins, of Urbana, for his development of the selenium photometer and its application to astronomical problems.

1914. William David Coolidge, of Schenectady for his invention of ductile tungsten and its application in the production of radiation.

1915. Charles Greeley Abbot, of Washington, for his researches on solar radiation.

1917. Percy Williams Bridgman, of Cambridge, for his thermodynamical researches at extremely high pressures.

1918. Theodore Lyman, of Cambridge, for his researches on light of very short wave-length.

1920. Irving Langmuir, of Schenectady, for his researches on thermionic and allied phenomena.

Grants for Research from the Rumford Fund.

1832–1862. 1. Observatory at Cambridge. For telescope and other apparatus $3776

2. Enoch Hale. For rain gauges and sundry expenses for experiments and investigations relating to the fall of rain 1697

1862. 3. Philander Shaw. Experiments relating to air-engines 600

1863. 4. Ogden N. Rood. Physical relations of iodized plate to light. (Appropriation subsequently transferred to another research, viz., photometry, 7.) 300

1864. 5. Wolcott Gibbs. For purchase of a Meyerstein spectrometer and Regnault's apparatus for measuring vapor tension 600

1865. 6. Josiah P. Cooke, Jr. For purchase of glass prisms to be used in an investigation of metallic spectra. (These prisms were purchased from the Academy by Professor Cooke in 1871.) 200

1866. 7. Ogden N. Rood. Photometry. (Appropriation 4, for relations of iodized plate to light, $300, transferred to this purpose.)

1867. 8. Wolcott Gibbs. For repairing Meyerstein spectrometer belonging to the Academy. (Additional to 5.) $100

1869. 9. Joseph Winlock. For purchase of spectroscopic instruments for observations of the solar eclipse of August, 1869 300

1870. 10. Benjamin Apthorp Gould. For photometric and spectroscopic apparatus for the Observatory at Cordova. (Apparatus subsequently purchased by the Argentine Government.) 500

1875. 11. John Trowbridge. Improvement of magneto-electric machine and induction coil 500

1876. 12. Henry A. Rowland. New determination of mechanical equivalent of heat 600

13. Samuel P. Langley. Researches on radiant energy 600

1877. 14. Benjamin O. Peirce, Jr. Investigation of the conduction of heat in the interior of bodies. ($60. only, called for.) 200

15. Edward C. Pickering. Atmospheric refraction . 520

1878. 16. Wolcott Gibbs, John Trowbridge, Edward C. Pickering. Experiments on photometry and polarimetry. (A small portion only of this appropriation was called for.) 500

17. Charles A. Young. In aid of observations on solar eclipse of July 29, 1878. (Appropriation not called for.) 300

18. Nathaniel S. Shaler. Investigation on loss of internal heat of earth in the neighborhood of Boston. (Appropriation not called for.) . . . 200

19. William W. Jacques. Experiments on the distribution of heat in the spectrum 100

20. Wolcott Gibbs, Edward C. Pickering, John Trowbridge. Determination of indices of refraction. (A small portion only of this appropriation was called for.) 500

1879. 21. John Trowbridge. Heat developed by magnetization and demagnitization of magnetic metals . 200

22. William W. Jacques. Radiation at high temperatures. (Additional to 19.) 200

	23. William A. Rogers. To procure a metric standard of length	$350
1880.	24. Silas W. Holman. Viscosity of gases	250
	25. Wolcott Gibbs. Construction of dynamo-electric machine of a new plan	150
	26. Samuel P. Langley. Distribution of heat in diffraction spectrum. (Additional to 13.)	300
1882.	27. Edward C. Pickering. Stellar photography, with a view of obtaining a method of estimating the brightness of stars	500
	28. John Trowbridge. Thomson effect and allied subjects	250
1883.	29. John Trowbridge. Addition to last preceding appropriation	100
	30. Frank N. Cole. Experiments on Maxwell's theory of light	50
1884.	31. Rumford Committee. For purchase of Rowland grating	40
	32. William H. Pickering. Experiments in photography	200
	33. John Trowbridge, Edward C. Pickering, Charles R. Cross. Experiments on standard of light	300
	34. Edward C. Pickering. Photometry. (Additional to 27.)	200
	35. William A. Rogers. Production of constant temperatures	100
	36. John Trowbridge. Effect of changes of temperature on magnetism	100
1885.	37. William A. Rogers. For Construction of constant temperature room. (Additional to 35.)	82
	38. Edward C. Pickering. Photometry. (Additional to 34.)	300
	39. William H. Pickering. Photography and new standard of light. (Additional to 32.)	300
1886.	40. William H. Pickering. Observations of Solar Corona, Eclipse of August, 1886	500
	41. Henry P. Bowditch. Calorimetric observations on the heat of the human body. ($100, only, called for.)	500
	42. John Trowbridge. Standard of light. (Appropriation subsequently transferred to another research, viz., radiant energy, 44.)	250

	43. Charles R. Cross. Thermo-electric effect in Munich shunt method. (Appropriation not called for.) .	$75
1887.	44. John Trowbridge. Investigations on radiant energy. (Appropriation 42, for Standard of light, $250, transferred to this purpose.)	
	45. Charles R. Cross and Silas W. Holman. Thermometry	250
	46. Erasmus D. Leavitt, Jr. Investigations upon a pyrometer. (Appropriation not called for.) . .	250
	47. John Trowbridge. Metallic spectra	250
1888.	48. John Trowbridge. Metallic spectra. (Additional to 47.)	500
	49. William H. Pickering. For observations on solar eclipse of Jan., 1889	500
1889.	50. Charles C. Hutchins. Investigation on lunar radiation	250
	51. Edwin H. Hall. Investigations on cylinder temperature	100
	52. Henry A. Rowland. Metallic spectra	500
1890.	53. Edwin H. Hall. Investigations on cylinder temperature. (Additional to 51.)	100
	54. Benjamin O. Peirce. Temperature changes in interior of solids. (Appropriation not called for.)	200
1892.	55. Daniel W. Shea. Velocity of light in magnetic field	250
	56. Benjamin O. Peirce. Propagation of heat within certain solid bodies. (Reappropriation of 54.) .	200
	57. Henry A. Rowland. Investigations on solar spectrum. (Additional to 52.)	250
1893.	58. William A. Rogers. Investigation on the pulsation of thermometers	175
	59. William H. Pickering. Observations in Arizona on transparency and steadiness of the air and on the changes in temperature on the planet Mars. (Appropriation not called for.)	500
1894.	60. Frank A. Laws. Thermal conductivity of metals.	300
	61. Edward L. Nichols. Radiation from carbon at different temperatures	250
1895.	62. Edwin H. Hall. Thermal conductivity of metals.	250
	63. Arthur G. Webster. Velocity of electric waves.	250
	64. Benjamin O. Peirce. Thermal conductivities of poor conductors. (Additional to 56.)	250

1896.	65. Henry Crew. Electric, chemical, and thermal effects of electric arc	$400
	66. Robert O. King. Thomson effect in metals . .	100
1897.	67. Arthur G. Webster. Velocity of light. (Appropriation not called for.)	500
	68. George E. Hale. For the construction of spectro-heliograph	400
	69. Arthur G. Webster. For the construction of revolving mirror. (Additional to 67. Appropriation returned.)	250
	70. Arthur G. Webster and Robert R. Tatnall. The Zeeman effect. (Appropriation not called for.)	100
1898.	71. Wallace C. Sabine. Researches on ultra-violet radiation	400
	72. Albert A. Michelson. New form of diffraction grating. (Echelon spectroscope.)	500
	73. Theodore W. Richards. For the construction of a microkinetoscope, to be applied to a study of the birth and growth of crystals	200
1899.	74. Wallace C. Sabine. Further researches on ultra-violet wave-length. (Additional to 71.) . . .	200
	75. Henry Crew. Spectrum of the electric arc. (Additional to 65.)	200
	76. Arthur G. Webster. Distribution of energy in various spectra studied by means of the Michelson interferometer and the radiometer. (Appropriation not called for.)	200
	77. Edwin B. Frost. To aid in the construction of a spectrograph especially designed for the measurement of stellar velocities in the line of sight . .	500
1900.	78. Edward C. Pickering. For constructing a new type of photometer to be used in an investigation on the brightness of faint stars, to be carried out by coöperation with certain observatories possessing large telescopes. (Additional to 38.)	500
	79. Theodore W. Richards. Transition temperatures of crystallized salts	100
	80. Arthur L. Clark. Molecular properties of vapors in the neighborhood of the critical point	250
	81. Charles E. Mendenhall. Investigations on a hollow bolometer. ($100 only, called for.) . .	200

82. George E. Hale. Application of the radiometer to the study of the infra-red spectrum of the chromosphere $500

83. Arthur A. Noyes. Effect of high temperatures on the electrical conductivity of salt solutions . . 300

1901. 84. Theodore W. Richards. Research on the expansion of gases 500

85. Henry Crew. Order of appearance of the different lines of the spark spectrum. (Additional to 75.) 100

86. Robert W. Wood. Anomalous dispersion of sodium vapor 350

87. Arthur G. Webster. For purchase of fluorite plates 65

1902. 88. Ernest F. Nichols. For the purchase of a spectrometer, in furtherance of a research on resonance in connection with heat radiations 300

89. Theodore W. Richards. For the construction of a mercurial compression pump to be used in a research on the Joule-Thomson effect. (Appropriation subsequently transferred to another research, viz., the experimental study of chemical thermodynamics, 92.) 750

90. Arthur A. Noyes. Effect of high temperatures on the electrical conductivity of aqueous solutions. (Additional to 83.) 300

91. Ralph S. Minor. Dispersion and absorption of substances for ultra-violet radiation 150

1903. 92. Theodore W. Richards. Experimental study of chemical thermodynamics. (Appropriation 89 for compression pump, $750, transferred to this purpose.)

93. Sidney D. Townley. For the construction of a stellar photometer 100

94. Edwin B. Frost. For the construction of a special lens for use in connection with the stellar spectrograph of the Yerkes Observatory for the study of radial velocities of faint stars. (Additional to 77.) 200

95. Ernest F. Nichols and Gordon F. Hull. In aid of the investigation of the relative motion of the earth and the ether by the method of "Fizeau's

polarization experiment." (Appropriation transferred to another research, viz., effect of motion of earth on intensity of radiation, 98) $250

96. George E. Hale. For the purchase of a Rowland concave diffraction grating to be used in the photographic study of the brighter stars . . . 300

97. Edward C. Pickering. For the construction of two stellar photometers to be placed at the disposal of the Rumford Committee. (Additional to 78.) . 150

98. Ernest F. Nichols and Gordon F. Hull. Effect of the motion of the earth on the intensity of radiation. (Appropriation 95 for Fizeau's polarization experiment, $250, transferred to this purpose.)

99. Frederic L. Bishop. Thermal conductivity of lead 75

100. Frederick A. Saunders. Characteristics of spectra produced under varying conditions 200

101. William J. Humphreys. Shift of spectrum lines due to pressure 300

102. Norton A. Kent. Circuit conditions influencing electric spark lines 250

103. Edward W. Morley. Nature and effects of ether drift 500

1904. 104. John A. Dunne. Fluctuations in solar activity as evinced by changes in the difference between maximum and minimum temperatures . . . 200

105. Carl Barus. Optical method of study of radioactively produced condensation nuclei. (Appropriation not called for.) 200

106. Dewitt B. Brace. Double refraction in gases in an electrical field 200

107. Robert W. Wood. Optical and other physical properties of sodium vapor. (Additional to 86.) 350

108. Norton A. Kent. (Additional to 102.) Circuit conditions influencing electric spark lines . . 100

109. Arthur L. Clark. Molecular properties of vapors in the neighborhood of the critical point. (Additional to 80.) 150

1905. 110. Dewitt B. Brace. Double refraction in gases in an electrical field. (Additional to 106.) . . . 200

111. Charles B. Thwing. Thermo-electric power of metals and alloys. $150
112. Harry W. Morse. Fluorescence 500
113. John Trowbridge. Electric double refraction of light 200
114. Edwin H. Hall. Thermal and thermo-electric properties of iron and other metals. (Additional to 62.) 200
115. Arthur B. Lamb. Specific heat of salt solutions 200
116. John A. Parkhurst. For the purchase of a Hartmann photometer 225
117. Charles B. Thwing. Thermo-electric power of metals. (Additional to 111.) 400

1906. 118. Edwin H. Hall. Thermo-electric properties of metals. (Additional to 114.) 100
119. Frederick E. Kester. Joule-Thomson effect in gases 50
120. Edwin H. Hall. Thermo-electric properties of metals. (Additional to 118.) 25
121. Sidney D. Townley. Appropriation of $100 for a stellar photometer, 93, returned.
122. Arthur A. Noyes. For the construction of a calorimeter for the determination of heats of reaction at high temperatures. (Additional to 90.). 300
123. Robert W. Wood. For the purchase of quartz mercury lamps. (Additional to 107.) . . . 200
124. Norton A. Kent. Spectral lines. (Additional to 108.) 75
125. Leonard R. Ingersoll. Kerr effect in the infrared rays 200
126. Frederick E. Kester. Thermal properties of gases flowing through porous plug. (Additional to 119.) 315

1907. 127. Harry W. Morse. Fluorescence. (Additional to 112.) 400
128. Percy W. Bridgman. Optical and thermal properties of bodies under extreme pressures . . . 400
129. Percy W. Bridgman. Optical and thermal properties of bodies under extreme pressures. (Additional to 128.) 400

1908. 130. Lawrence J. Henderson. New method for the

direct determination of physiological heats of reaction. (Balance of appropriation, $100, returned.) $200

131. Joel Stebbins. Use of selenium in photometry 100

132. Willard J. Fisher. Viscosity of gases. (Balance of appropriation, $41, subsequently transferred to Edward L. Nichols. See 175.) 100

133. Norton A. Kent. For the purchase of a set of echelon plates. (Additional to 124.) 400

134. Joel Stebbins. Use of selenium in stellar photometry. (Additional to 131.) 100

1909. 135. William W. Campbell. For the purchase of a Hartmann photometer to be used in the measurement of polarigraphic images of the solar corona 250

136. Robert W. Wood. Optical properties of mercury vapor. (Additional to 123.) 150

137. Martin A. Rosanoff. Fractional distillation of binary mixtures 300

138. Charles E. Mendenhall. Free expansion of gases 300

139. William W. Campbell. For the purchase of certain parts of a quartz spectrograph 300

140. Martin A. Rosanoff. Fractional distillation of binary mixtures. (Additional to 137.) . . . 200

141. Leonard R. Ingersoll. Optical constants of metals 300

142. Joel Stebbins. Researches with the selenium photometer. (Additional to 134.) 350

143. William W. Campbell. Polariscopic study of the solar corona by means of a Hartmann photometer. (Additional to 135.) 125

1910. 144. Charles E. Mendenhall and Augustus Trowbridge. Influence of ether drift upon the intensity of radiation 250

145. Charles E. Mendenhall. Free expansion of gases. (Additional to 138.) 250

146. Frank W. Very. For the purchase of photographic glass plates of the spectrum by George Higgs 50

147. Maurice DeK. Thompson. The high temperature equilibrium of the system of materials employed industrially in the carbide process for the fixation of atmospheric nitrogen 100

148. Percy W. Bridgman. Thermal and optical properties of bodies under extreme pressures. (Additional to 129.) $400
149. Charles L. Norton. Thermal insulation . . . 400
1911. 150. Joel Stebbins. Researches with the selenium photometer. (Additional to 142.) 200
151. Martin A. Rosanoff. Fractional distillation of binary mixtures. (Additional to 140.) . . . 300
152. Daniel F. Comstock. Possible effect of the motion of the source on the velocity of light . . . 100
153. Gilbert N. Lewis. Free energy changes in chemical reactions 150
154. Robert W. Wood. Optical properties of vapors. (Additional to 136.) 150
155. Daniel F. Comstock. Possible effect of the motion of the source on the velocity of light. (Additional to 152.) 150
156. Frank W. Very. Intensity of spectrum lines. (Additional to 146.) 150
157. John Trowbridge. For research of Harvey C. Hayes on thermo-electricity 300
158. Robert W. Wood. Optical properties of vapors; long heat-waves. (Additional to 154.) . . . 150
159. Arthur L. Clark. Physical properties of vapors in the neighborhood of the critical point. (Additional to 109.) 250
1912. 160. Gilbert N. Lewis. Free energy changes in chemical reactions. (Additional to 153.) 250
161. Norton A. Kent. Purchase of a lens for magneto-spectroscopic researches. (Additional to 133.) 375
162. Frederick A. Saunders. Spectroscopic studies in the ultra-violet. (Additional to 100.) 100
163. William O. Sawtelle. Spectra of light from oscillatory discharge 250
164. George W. Ritchey. Construction of reflecting telescope employing mirrors with new forms of curves 500
1913. 165. Edward L. Nichols. For research of W. P. Roop on effect of temperature on the magnetic susceptibility of gases 250
166. Frederick G. Keyes. For payment of computa-

tion expenses of thermodynamic tables for ammonia $300

167. In aid of publication of Marie's Annual International Tables of Constants (at the request of the Council) through Theodore W. Richards . 100

168. Gilbert N. Lewis. Free energy changes in chemical reactions. (Additional to 160.) 300

169. William O. Sawtelle. Spectra of the light from spark in an oscillatory discharge. (Additional to 163.) 300

170. Harvey N. Davis. Thermodynamical researches 200

171. Louis V. King. To defray expenses of computation for research on scattering and absorption of solar radiation in the earth's atmosphere . . . 250

1914. 172. Alpheus W. Smith. Hall and Nernst effects in the rare metals 100

173. Charles G. Abbot. Applications of solar heat to domestic purposes 150

174. Percy W. Bridgman. Thermodynamical researches at high pressures. (Additional to 148.) 250

175. Edward L. Nichols. Hall effect and allied phenomena in tellurium and selenium. (Balances of 132 and 165, $282, transferred to this Research.)

176. Percy W. Bridgman. Thermal effects of high pressures. (Additional to 174.) 150

177. Frederick A. Saunders. On the spectra of metallic vapors. (Additional to 162.) 100

178. Frederic Palmer, Jr. Properties of light of extremely short wave-length 200

179. Henry Crew. Specific heat of liquids 200

180. Charles A. Kraus. Solutions in liquid ammonia; for purchase of a refrigerating apparatus . . . 300

181. Herbert P. Hollnagel. Extreme infra-red spectrum; for purchase of motor-generator . . . 300

1915. 182. Joel Stebbins. Research with improved photo-electric-cell photometer upon variable stars. (Additional to 150.) 140

183. Farrington Daniels. Specific heats; for purchase of calorimetric apparatus 330

184. Raymond T. Birge. Comparator for spectroscopic researches 200

185. Percy W. Bridgman. Thermal phenomena at high pressures. (Additional to 176.) $400
186. Arthur L. Clark. Physical properties of vapors near critical point. (Additional to 159.) . . . 300
187. Gilbert N. Lewis. Free energy. (Additional to 168.) 300
1916. 188. Harrison M. Randall. Infra-red spectrum. (For salary of assistant.) 200
189. Raymond T. Birge. For purchase of comparator. (Additional to 184.) 175
190. Louis V. King. Molecular constants of gases from 25° K to 1273° K. (Research discontinued, appropriation returned.) 250
191. Frederic Palmer, Jr. Light of extremely short wave length. (Additional to 178.) 100
192. Robert A. Millikan. Photo-electric properties of metals in extreme vacua 500
193. John A. Parkhurst. Photometric scale of stellar magnitudes 300
194. Everett T. King. Color of pigments 25
195. Edward Kremers. Chemical action of light on organic compounds 300
1917. 196. Floyd K. Richtmyer. Optical properties of thin films 500
197. Norton A. Kent. Spectral lines. (Additional to 161.) 400
198. Ancel St. John. Spectra of X-rays 200
199. David L. Webster. Intensity of lines in X-ray spectra. (For payment of assistant.) . . . 100
200. Frederic Palmer, Jr. Light of very short wave length. (Additional to 191.) 100
201. Bartholomew J. Spence. Color intensity photometer 75
202. Bartholomew J. Spence. New form of radiometer 150
203. Roswell C. Gibbs. Absorption of organic and other solutions for ultra-violet, visible and infra-red rays 500
204. Wesley M. Baldwin. Sensitization of animal tissues for X-rays by chemical means 125
205. Raymond T. Birge. Structure of series spectra. (Additional to 189.) 150

206. Ancel. St. John. For the purchase of refrigerating machine for research on crystal structure by X-rays $500
207. In aid of Publication of Marie's Annual International Tables of Constants, through Theodore W. Richards. (Additional to 167.) 250

1918. 208. Floyd K. Richtmyer. Optical properties of thin films. (Additional to 196.) 500
209. Arthur L. Foley. Photography of phases of electric discharge 150
210. Orin Tugman. Conductivity of thin metallic films when exposed to ultra-violet light . . . 100
211. Roswell C. Gibbs. Absorption of organic and silver solutions for ultra-violet and infra-red rays. (Additional to 203.) 250
212. Louis T. E. Thompson. Development of a gun-sight for anti-aircraft guns 250

1919. 213. Harrison M. Randall. Infra-red spectrum. (Additional to 188.) 200
214. Alpheus W. Smith. Hall effect and allied phenomena in rare metals and their alloys. (Additional to 172.) 100
215. In aid of publication of Marie's Annual International Tables of Constants, through Julius Stieglitz. (Additional to 207.) 250
216. Arthur G. Webster. Researches on pyrodynamics and practical interior ballistics 500
217. Percy W. Bridgman. Effect of temperature and pressure on physical properties of materials, particularly thermal conductivity. (Additional to 185.) 400
218. Horace L. Howes. Effect of temperature on luminescence and selective radiation of rare earths 500
219. Frances G. Wick. Phosphorescence of hexagonite and fluorite, at ordinary and low temperatures 300
220. Robert W. Wood. Optical researches. (Additional to 158.) 350
221. Frederick G. Keyes. Heats of neutralization at different temperatures. (Additional to 166.) . 300

1920. 222. Frederick A. Saunders. Spectral lines. (Additional to 177.) $150

223. David L. Webster. X-ray spectra. (Additional to 199.) 350

224. In aid of publication of Marie's Annual International Tables of Constants, through Julius Stieglitz. (Additional to 215.) 250

225. Leonard R. Ingersoll. Polarizing effect of diffraction gratings 150

226. Harrison M. Randall. Structure of spectra, in infra-red. (Additional to 213.) 500

227. Arthur G. Webster. Pyrodynamics and interior ballistics. (Additional to 216.) 500

228. Norton A. Kent. Spectral lines. (Additional to 197.) 200

229. William W. Campbell. For the purchase of a special photographic lens. (Additional to 139.) 360

230. Horace L. Howes. Researches in luminescence. (Additional to 218.) 90

231. Percy W. Bridgman. Thermal and optical properties of bodies under high pressures. (Additional to 217.) 400

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